Lower Santa Cruz River Basin Study:

Study Process Overview and Role of Stakeholder Advisors

Eve Halper, Natural Resources Specialist
Bureau of Reclamation
Stakeholder Advisors Meeting
April 24, 2017
Lower Santa Cruz River (LSCR) Basin Study Summary

- Addresses the impacts of changing climate, population and other factors on water use through 2060
- Focuses on spatial distribution of water resources in the Tucson basin (Tucson Active Management Area)
- Includes analysis of environment (riparian areas)
- Employs a scenario approach to explore range of futures (with and without adaptation measures)
- Uses multiple climate projections as input to groundwater and surface water models
- **Incorporates Input from Public Stakeholders**
LSCR Basin Study Objectives

1) Identify Where Physical Water Resources are Needed to Mitigate Supply-Demand Imbalances

2) Develop Adaptation Strategies to Improve Water Reliability for Municipal, Industrial, Agricultural and Environmental Sectors
Key Terms

• **Risk** - threats to life, health and safety, the environment, economic well-being, and other things of value

• **Vulnerability** – The degree to which physical, biological, and socio-economic systems are susceptible to and unable to cope with adverse impacts

• **Adaptation** - Adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects

**Source:** U.S. Global Change Research Program, http://www.globalchange.gov/climate-change/glossary
Public Involvement: Key Part of Process

Step 1: Project future supply & demand imbalances (without adaptation measures) (TODAY)

Step 2: Evaluate risks to infrastructure and other systems

Step 3: Develop and investigate adaptation strategies (structural and non-structural)

Step 4: Perform trade-off analysis of strategies

Input: scenarios and assumptions

Input: Adaptation Strategies

Input: Trade-off Analysis
Step 1: Project imbalances
Step 2: Evaluate Risks
Step 3: Adaptation strategies
Step 4: Trade-off analysis

TODAY

Present

Future without Additional Adaptation

Future with Additional Adaptation

Study Process and Scenario Planning

Benefits and Costs
Scenario Planning

**Scenarios**: plausible futures, based on consistent assumptions

ADWR TAMA Groundwater Model
Potential Scenarios

Best Case
- High Supply
- Low Demand

Worse Case
- Low Supply
- High Demand

Water Supply

Water Demand

High Supply

High Demand

Low Supply

Low Demand

"Worse" Case
Scenarios Focus on Risk

“Base Case” (w/o Climate Change)
Supply and Demand

“Best Case”
Supply and Demand

“Worse Case”
Supply and Demand

Low Risk
High Risk
Scenario Planning

**Scenarios**: plausible futures, based on consistent assumptions about driving forces

**Driving Forces**: Factors that will have the greatest influence on future conditions

**Types of Driving Forces**:
- **Climate**
  - Temperature
  - Precipitation
- **Socio-Economic**
  - Demographic
  - Economic
  - Technological
  - Regulatory
Socio-Economic Driving Forces
(Demographics, Economics, Technological, Regulatory)

Climate Driving Forces
(Precipitation, Temperature)

Supply and Demand

- CAP Deliveries
- Local Ground and Surface Water
- Recycled Water
- Stormwater

- Municipal
- Industrial
- Agricultural
- Environmental (Riparian ET)

RECLAMATION
Outflows

ADWR TAMA
Groundwater Model

Drivers:
- Primarily Socio-Economic Forces
- Primarily Climate
- Estimated within Model

Groundwater Detail

Inflows

- Mountain Front Recharge
- Stream Infiltration
- Underflow from other basins
- Artificial Recharge (CAP and effluent)
- Agricultural Recharge
- Incidental Recharge

Outflows

- Pumping (Municipal, Industrial, Agricultural)
- Evapotranspiration by Riparian Areas
- Underflow to other basins
Socio-Economic Forces - CAP Service Area Model

**CAP Service Area Model (CAP: SAM)**

- **All Major Water Using Entities**
  - 80 Municipal Providers
  - 23 Irrigation Districts
  - 12 Tribes and Districts
  - 20+ other user categories (CAGR, AWBA, Industrial users, etc.)

- **16 Water Supply Types**
  - Includes Surface Water, Effluent, CAP, LTSC, Groundwater, Recovered Water, etc.
  - Incorporates shortage scenarios from Colorado River Simulation model (CRSS)

- Models municipal, agricultural and industrial demands
- Demand estimated by water provider
- Matches each demand with supplies in order of preference
Introduction to Central Arizona Project Service Area Model (CAP-SAM)

Lower Santa Cruz River Basin Study

Ken Seasholes, Resource Planning & Analysis Manager, Central Arizona Project
Stakeholder Advisors Meeting
April 24, 2017
Introduction to CAP Service Area Model

• CAP:SAM is a tool for projecting supply & demand in Pima, Pinal and Maricopa Counties

• Accounts for complex legal and physical characteristics of users and supplies

• Designed to easily generate “what-if” scenarios
Introduction to CAP Service Area Model

- Like other computer models, CAP:SAM attempts to simulate aspects of the “real world” by representing key attributes of a complex system
  - Relationships
  - Parameters
  - Assumptions
  - Scenarios
Introduction to CAP Service Area Model

• Complex relationships among supply & demand factors
  – Within demand (e.g., housing development on Ag land)
  – Within supply (e.g., use of long-term CAP contracts affects Excess CAP)
  – Between supply & demand (e.g., reductions in interior use affect effluent supplies)

• Significant uncertainties across multiple dimensions
  – The rate of growth
  – The location of growth
  – Changes in current and future demand factors
  – The use of different supply types
  – The reliability of those supplies
Introduction to CAP Service Area Model

• Example: Agricultural demand is simulated as the relationship among the following parameters
  – Acres in production
  – Crop types
  – Crop consumptive use
  – Irrigation efficiency
  – Climate factors
    • Effective precipitation
    • Heat stress

National Agricultural Statistics Service
CropScape Data Layer, 2013
• CAP:SAM allows the user to make assumptions about dozens of different parameters

• The model then performs a large number of calculations that estimate and track the results, based on the underlying relationships

• As a tool, CAP:SAM is most useful when it is used to test and compare a range of possible future conditions (i.e., scenarios)
Introduction to CAP Service Area Model

• Adjustable rate and spatial pattern of growth
• Variable rates of municipal use and conservation
• Projected agricultural demand, including changes in efficiency, crop types and consumptive use
• Calculated rate of urbanization of active Ag land
• Dynamic distribution of recharge activity
• Tracking of water supply portfolios, including leases, exchanges and long-term storage credits
• Linkage to Colorado River modeling
• Calculation of CAGRD replenishment obligation
Scenario Planning
Demand Matrix for Stakeholder Advisors’ Input

Lower Santa Cruz River Basin Study

Kathleen Chavez, Water Policy Manager, Pima County Stakeholder Advisors Meeting
April 24, 2017
Driving Forces of Municipal, Agricultural, Industrial Water Demand in CAP-SAM

**Municipal**
- Population Growth Rate
- Location of Growth
- Growth Characteristics (Outward vs. Infill)
- Gallons per Housing Unit Per Day (GPHUD)

**Agricultural**
- Urbanization of Agricultural Land
- Crop Water Use

**Industrial – Manufacturing**
- Served by Municipal Water Provider or not

**Industrial – Mining**
- Existing and Future Large Users
Example of Scenario Matrix Concept

<table>
<thead>
<tr>
<th>Driving Force</th>
<th>Demand Scenario 1</th>
<th>Demand Scenario 2</th>
<th>Demand Scenario 3</th>
<th>Demand Scenario 4</th>
<th>Demand Scenario 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal Demand Driving Forces</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>a. Population Growth Rate</td>
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<tr>
<td>b. Outward Growth vs. Infill</td>
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<tr>
<td>c. Growth Density</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>d. Gallons per Housing Unit per Day Water Use</td>
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</tr>
</tbody>
</table>
Tucson Metropolitan Area
Population Growth Projections
(AZ Dept of Administration)

Low Risk

High Risk

Low Series
Medium Series
High Series

Population (AZ Dept of Administration)
Location of Growth

Infill Scenario: Slow & Compact

Outward Growth: Rapid & Outward

http://www.connect2edmonton.ca/showthread.php?21142-Raymond-Block-6-storeys-Mixed-Use-Proposed/page4

Credit: Jeff Dean (Source: Wikipedia)
Water Demand
(gallons per housing unit per day)

- Declines as Expected
- No Change
- Declines Faster than Expected
Agricultural Irrigation Demand
(consumptive water use of crop type)

Crop Type is Driven by Market Demand, mostly

High Risk
- Areas Convert to Higher Water Consumptive Use Crops
  - No Change in Consumptive Use Crops
- Some Areas convert to Lower Water Consumptive Use Crops

Low Risk

Conversion of Agricultural Land to Residential Use

High Risk
- More development on undeveloped land before replacing agriculture
- Current trend
- Some areas convert to low water use residential developments

Low Risk

By Riverrat303 (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons
Industrial Demand - Manufacturing

High Risk

- Rapid Economic Growth that Depends on Groundwater/ Minimal Improvements in Water Efficiency
- Moderate Economic Growth
- Slow Economic Growth and/or Greatly Improved Water Use Efficiency

Credit: Energy.gov (Wikipedia)
Industrial Demand – Water for Mining

Existing Mining
- More Mining
- Same Mining
- Less Mining

Future Mining - Development and Timing
- Develops quickly
- Develops slowly
- Does not develop

https://pubs.usgs.gov/gip/deserts/minerals/
Riparian Evapotranspiration

• Not directly measured as other types of demand
• Not modeled within CAP:SAM
• ADWR TAMA Groundwater Model estimates riparian ET at 8,000 acre-feet/year
• Riparian areas affected by temperature, available surface water and shallow groundwater
• Adaptation will include measures to support / enhance riparian areas

Credit: Pima County Office of Sustainability and Conservation
Basin Study Next Steps

• Run Climate Projections through Hydrologic Models
• Select Best and Worse Case Climate / Hydrology Scenarios, including Stakeholder Input
• Combine Demand Scenarios with Selected Climate Projections, including Stakeholder input
• Run Supply and Demand Scenarios in through models
• Assess Risks to Reliability under each Scenario
# Draft Demand Matrix
(for input into CAP:SAM)

<table>
<thead>
<tr>
<th>Driving Forces</th>
<th>Demand Scenario 1 Baseline</th>
<th>Demand Scenario 2 Slow Compact Growth</th>
<th>Demand Scenario 3 Slow Outward Growth</th>
<th>Demand Scenario 4 Rapid Outward Growth</th>
<th>Demand Scenario 5 Rapid Outward Growth Plus Mining &amp; No Replenishment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Municipal Demand:</strong> Population Growth Rate</td>
<td>Medium</td>
<td>Low Series</td>
<td>Medium Series</td>
<td>High Series</td>
<td>High Series</td>
</tr>
<tr>
<td><strong>Municipal Demand:</strong> Infill vs. Outward Growth</td>
<td>Baseline</td>
<td>In-Fill/Redevelopment</td>
<td>Slow Outward</td>
<td>Rapid Outward</td>
<td>Rapid Outward</td>
</tr>
<tr>
<td><strong>Municipal Demand:</strong> Gallons Per Household Unit Per Day (GPHUD)</td>
<td>Decline as expected</td>
<td>Decline faster than expected</td>
<td>Decline as expected</td>
<td>No change in current GPHUD</td>
<td>No change in current GPHUD</td>
</tr>
<tr>
<td><strong>Municipal Demand:</strong> Additional recharge</td>
<td>per current CAP-SAM assumptions</td>
<td>Year 2020</td>
<td>Year 2030</td>
<td>Year 2030</td>
<td>Never</td>
</tr>
<tr>
<td><strong>Municipal Demand:</strong> Develop Ag Land or Undeveloped Land</td>
<td>Baseline</td>
<td>Low GPHUD development tends to replace high water use ag land.</td>
<td>CAP-SAM Baseline</td>
<td>Higher GPHUD development occurs on undeveloped land before replacing agriculture</td>
<td>Higher GPHUD development occurs on undeveloped land before replacing agriculture</td>
</tr>
<tr>
<td><strong>Agricultural Demand:</strong> Consumptive Use (CU) Crop</td>
<td>Baseline</td>
<td>Some ag areas convert to low CU crops</td>
<td>No change in CU crops</td>
<td>Some ag areas convert to higher CU crops</td>
<td>Some ag areas convert to higher CU crops</td>
</tr>
<tr>
<td><strong>Agricultural Demand:</strong> Groundwater Savings Projects</td>
<td>per current CAP-SAM assumptions</td>
<td>Highest savings start 2018</td>
<td>Highest savings start in 2018</td>
<td>Half of highest savings start in 2025</td>
<td>No savings</td>
</tr>
<tr>
<td><strong>Industrial Demand:</strong> Manufacturing</td>
<td>Baseline</td>
<td>Slow economic growth and/or greatly improved water use efficiency</td>
<td>Moderate economic growth within existing water service areas, expected improvements in efficiency</td>
<td>Rapid economic growth that depends on groundwater, minimal improvements in efficiency</td>
<td>Rapid economic growth that depends on groundwater, minimal improvements in efficiency</td>
</tr>
<tr>
<td><strong>Industrial Demand:</strong> Mining</td>
<td>Baseline</td>
<td>No new mines</td>
<td>New mine in 2020-2030</td>
<td>New mine in 2020, Existing mines expand</td>
<td>New mine in 2020, Existing mines expand</td>
</tr>
<tr>
<td><strong>Environment’s Demand:</strong> Riparian Evapotranspiration</td>
<td>Baseline</td>
<td>Changes with climate and availability of surface water and shallow groundwater</td>
<td>Changes with climate and availability of surface water and shallow groundwater</td>
<td>Changes with climate and availability of surface water and shallow groundwater</td>
<td>Changes with climate and availability of surface water and shallow groundwater</td>
</tr>
</tbody>
</table>
What we are going to discuss today?

1. Have we represented the key driving forces affecting water demand?

2. Are the “building blocks” for the scenarios reasonable?

3. Are the scenario “building blocks” in logical groups?
GUIDED DISCUSSION OF DEMAND MATRIX